

Da Costa (J.M.)

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RESPIRATORY PERCUSSION.

By J. M. DA COSTA, M.D.,

PROFESSOR OF THE PRACTICE OF MEDICINE IN JEFFERSON MEDICAL COLLEGE, PHILADELPHIA;
PHYSICIAN TO THE PENNSYLVANIA HOSPITAL.



In making examinations of the chest I have been often struck with the difference of sound elicited on percussion when the patient is breathing quietly or in a forced manner, and have thought that this might be made a matter of valuable investigation. Having now for years paid attention to the subject, I have been gradually able to work out what I believe will add a method of physical exploration, which, if I mistake not, will tend to clear up, and by a very simple process, many obscure problems in the discrimination of pulmonary affections. For this new means of diagnosis I propose the name of *Respiratory Percussion*. The term is, I know, not wholly unobjectionable; but it is convenient and sufficiently descriptive.

Respiratory percussion will deal then with the appreciation of the changes in the percussion note developed by the person examined holding his breath in a full inspiration or a forced expiration. There is an undoubted difference found under either circumstance when compared with the sound elicited during quiet breathing. As regards inspiration, this is more readily detected than as regards expiration; and whether this be the case or not it is so much easier for the patient, that inspiratory percussion is far more generally applicable. Most of the results commented on in this paper have been, indeed, obtained by a study of the inspiration; but the expiration has not been entirely neglected, and here and there the help it affords will be alluded to.

Before, however, explaining what the results are when this method of physical exploration is applied to diseased conditions, it is necessary, that

we may have a standard for comparison, to inquire into the effect of respiratory percussion on the chest sounds in health. I subjoin a summary of a large number of observations grouped in accordance with the regions usually explored, and made on men having chests of good expansive power.

At the apices, and especially at what is described as the infraclavicular region, a full held inspiration increases the resonance, makes the sound fuller, and raises the pitch; and where, as is so common, the left side has normally a higher pitch, this disparity is preserved.

Below the apices, say from the upper border of the fourth rib downwards to where the pulmonary resonance ceases, the same holds good, but, even making allowance for the cardiac region, the resonance is relatively less increased on the left than on the right side.

Turning to the posterior part of the chest, we find, at the upper portions, in the supraspinous fossæ, and on a line towards the spine, that a long-drawn held inspiration makes the percussion sound much fuller and raises the pitch. In several observations this was noted as higher on the right side, and some difference was preserved in the inspiratory effort.

In the region between the scapulæ and in both infrascapular regions, the tone on gentle percussion is distinctly pulmonary, and the pitch moderately high. On the left side, on ordinary percussion, an admixture of a tympanitic sound with the pulmonary resonance may be detected, certainly in the infrascapular region. The pitch on the left, both in the lower scapular and infrascapular regions, is somewhat lower on the left than the right. A full held inspiration elevates the pitch generally, increases the resonance very much, but usually makes the difference between the sides less apparent.

These are the facts noted with reference to the inspiration. A held and complete expiration will greatly lessen at the apices the resonance and lower the pitch, and though the phenomena are most clearly made out at the upper part of the chest anteriorly, the same general facts will be observed on percussing at any part over the lungs while in a fixed expiration.

As regards the quality of the percussion note, it is but little changed; it remains during these arrested respiratory movements that of pulmonary resonance; perhaps there is a little less softness, and the slighter hardness corresponds to greater resistance to the percussing finger. But in the held inspiration we obtain nevertheless the idea of a greater mass of tone; in the held expiration the reverse. The conditions of pitch alluded to I found most constant. Increase in volume of percussion sound goes, it is always asserted, hand in hand with fall of pitch. Not so here; and the exception may, I conceive, be explained by the altered tension of the structures, and then the slight change in quality mentioned is more apt to be

found with heightened pitch. But whether this be the explanation or not, the fact is very appreciable.

I have already stated that the observations thus far alluded to were made on men. In women the mammary regions interfere somewhat with the readiness with which the signs may be elicited; still they are in the main the same, and so they are in children, though, of course, we cannot always easily get a child to hold its breath sufficiently long for purposes of study.

But to turn from the results obtained in health to those presented in disease. And here let us take up one by one the more common pulmonary affections. We begin with *bronchitis*. We find in this malady the percussion resonance, practically speaking, unaffected. Yet where extremely abundant secretions exist, and obscure the breath sounds, the clearness of the note may become impaired, and we are in doubt as to the state of the pulmonary textures. Respiratory percussion removes the doubt; the chest struck while in a full inspiration returns a sound exactly corresponding to the sound we should obtain in health. If, however (and here at once a point of value becomes apparent), there be an extension to the finer structures and beginning consolidation, the note does not become fuller and more resonant, and the difference between the damaged point and the surrounding parts or corresponding portions of the other side is very manifest. If, however, the lung be merely collapsed, respiratory percussion gives an almost normal sound, unless the collapse be extensive and the power of expanding the lung be lost, or inflammation beset the collapsed lobules. And, as I had not very long since an opportunity of noticing in a child, the fact of the sound becoming under observation less and less changed by the breathing effort, goes to prove that this condition of things has happened.

In *acute lobar pneumonia* the dulness on percussion remains unchanged by a full inspiration during the stage of perfect hepatization. As resolution begins, the note heard on respiratory percussion is more resonant, more pulmonary. And this change may show itself in advance even of returning crepitation. Thus, in a case of pneumonia of the middle of the right lung which I saw last winter, and in which loud râles completely masked the blowing breathing, the dulness on percussion was found to be uninfluenced by full held inspiration, excepting the slightest rise in pitch. As, however, resolution began, and before returning crepitation was marked, respiratory percussion returned distinct pulmonary resonance.

Chronic pneumonia is so closely associated in its clinical features with phthisis, that it will be more convenient to discuss some of the traits when examining into this malady. But I may mention here what I have noticed in some cases of chronic pneumonia in which I know the further progress of the affection, and am cognizant that it ended in recovery.

In one instance, in a child eight years of age, in which the lung fully,

though very gradually, cleared up, the consolidation was found at the lower part of the left lung, nine months after an attack of acute pneumonia. The dulness was decided, but did not amount to flatness. It lessened considerably on full held inspiration, proving that the lung texture was already partly pervious. I considered this a favourable element in the prognosis, and the opinion given was confirmed by the issue. And we may find—as in a case of chronic consolidation, of a year's standing, that presented itself to me in June, 1873—that while over the lower part of a lung, where there was with dulness on percussion extreme feebleness of breath-sound, though with increased fremitus, the dulness was scarcely influenced by full held inspiration, at the upper part the resonance became distinctly clearer, teaching that the process of absorption had there commenced. Again, in a patient referred to me by Dr. John S. Dickson, of Pittsburgh, in October, 1873, in whom the left lung was consolidated, respiratory percussion, while it made the difference between the two sides very manifest, showed a considerable clearing on the left. I learned from a letter kindly sent me by Dr. Dickson not long since, that the lung symptoms have disappeared. The same could unfortunately not be said of a mitral valve trouble from which the patient suffered.

While alluding to this case, I may mention a further point it suggests with reference to the mode of diagnosis under discussion. We see, at times, puzzling cases of persons who with organic valvular disease have been spitting blood, are perhaps born of consumptive families, and have suspicious physical signs at the apex of a lung, have impaired breathing, somewhat prolonged expiration, râles, slight percussion dulness. Is there or is there not tubercular disease? Very generally not. And we find the apparent dulness, due to heavy local congestion of the lung, with possibly slight tissue consolidation, wholly, or at least very largely, disappearing under full held inspiration, far more so than if with the same physical signs there had been tubercular deposition.

In cases of *pleurisy* we obtain much aid from respiratory percussion. Over the seat of plastic exudation of ordinary extent—instances of an extraordinary kind I have not had occasion to observe since engaged in this inquiry—forced inspiration diminishes the slight dulness that exists. Over the seat of a marked pleuritic effusion, actually no change takes place in the flat percussion note. At the very edge, however, percussion practised during held inspiration strikingly clears the sound, or, rather, brings out the contrast between the pulmonary resonance above and the abrupt tone of dulness. We can turn this well to account in those instances we sometimes meet with where, with dulness at the lower part of the chest, we are in doubt if the trouble be pleuritic effusion or chronic pneumonia. When, by respiratory percussion, the dulness at its uppermost limit becomes sharply defined, while it is unaltered below, it is an effusion. When the dulness changes in part or remains unchanged

without a sharp line developed on full breathing, it is consolidated lung. I found this admirably illustrated in a case I saw in May, 1874, and watched for seven months afterwards. Here ægophonic twang existed just at the edge of the effusion; the lung was slightly dull, but on respiratory percussion cleared, and the abrupt dulness proved the affection pleuritic.

Of still greater value is respiratory percussion in those instances of pleuritic effusion in which we have blowing respiration at the back of the lung, and in which the question arises whether or not pneumonia coexists. How difficult it may be to settle this question is seen by the long and cumbersome rules laid down by leading authorities, and withal the amount of diagnostic trust to be reposed in them is not so great, that it is not generally acknowledged that the rules may mislead. The test I beg to offer is the simple one already indicated, somewhat extended. At the lower part of the chest the flat note remains unchanged; so will the sound over the upper part of dulness by forced respiration be practically uninfluenced if there be pneumonic consolidation. But if the blowing respiration be simply from compression or condensation of the lung, and not from hepaticization, decided clearness takes the place of the dulness. I have now repeatedly found the value of this rule; but in no case did it stand me in better stead than in this.

A gentleman, 60 years of age, was seized with violent pleuritic pain, soon followed by an effusion on the right side. Notwithstanding the occurrence of this, it hurt him so much to be moved, that I had no good opportunity of examining the back of the chest for several days. When I did so, I found the most marked bronchial, even tubular respiration above the angle of the scapula. The voice there was ringing, and distinctly transmitted, and from the very hurried breathing and anxious face it was but too evident that my patient was extremely ill. Had a pneumonia set in to complicate the pleurisy, or had the pleural lesion masked the lung trouble from the onset? True, there was neither cough nor expectoration, nor marked râles. But all these may be absent in pneumonia. I feared much that a grave pulmonary inflammation was before me, which would seriously influence the chances of recovery. I studied the tubular breathing closely, and all I could find was that it was less high-pitched and ringing than is common in pneumonia. But percussion gave the most comforting knowledge. The sound which was very dull below and over the seat of almost suppressed breathing, was only slightly dull where the supposed hepaticized lung was, and this dulness disappeared on full held inspiration. I assured my patient, who himself feared much that he had pneumonia, that no new and grave trouble had arisen, and in watching the case further saw it terminate as one of pleurisy with speedy absorption. Until the bronchial breathing disappeared—which it did in a few days—respiratory percussion always gave the same hopeful information.

While describing pleurisy, let us for completeness' sake see how some of

its rarer features are influenced by respiratory percussion. The tympanitic note obtained at times at the apex is lost by full held inspiration. Thus, in an instance recently at the Pennsylvania Hospital of large pleuritic effusion on the left side, in which the tympanitic percussion sound at the left apex decidedly contrasted with the lower pitched normal pulmonary resonance of the right, while a forced inspiration made this more resonant and slightly raised the pitch, it effaced the tympanitic character of the upper part of the left lung, rendering the sound somewhat duller, more like impaired pulmonary resonance. In doing this it hardly modified the pitch, only raised it slightly.

In those instances of pleurisy in which perforation takes place and pus is voided often for so long, respiratory percussion will help us in deciding how much the lung is bound down or otherwise implicated. Thus in a gentleman whom I saw in June, 1873, with a fistulous opening that had been discharging pus for twenty-one months, the whole of the left lung was dull on percussion, but the respiration was heard everywhere, even at the lower part of the chest. Excepting here where the physical signs of consolidation existed, the lung cleared up markedly on forced breathing, making the dulness of the inferior portion, in part intensified perhaps by a slight fluid accumulation, extremely evident.

In turning to *phthisis*—and I use the word now without attempting to distinguish the varieties particularly—we find respiratory percussion giving us much to study. Indeed, so many points arise that I shall in this paper do no more than attempt to bring forward some of those that are clearly defined. In the very early stages of tubercular deposit, when auscultation detects for us prolonged expiration just beginning, with, perhaps, some enfeeblement of the inspiration at the apex, and ordinary percussion shows but little, or a doubtful difference between the two sides, respiratory percussion may help us greatly by making the difference more marked. It seems at times, on the affected side, to develop a dulness which previously cannot be said to have existed; or at all events, if it do not give this result, it makes the resonance of the damaged lung only slightly greater, raises the pitch, too; but does not bring out these changes strikingly as it does on the healthy side. On the other hand, in more than a few instances of persons who had been losing flesh, came of a tubercular family, had want of expansion at the upper part of the chest, and in whom the diagnosis of tubercular disease seemed probable but was doubtful, I have allowed myself to be influenced by the normal results developed by respiratory percussion, and, tracing these cases up for long periods, have found that the impression made, proved correct. And with these normal results I must class the fact that percussion in full expiration, while it showed less resonance, did not exhibit that decided modification and lessening of pulmonary tone we obtain when the lung has begun to be solid.

There are some other matters connected with the beginning of tubercular disease, such as the varying changes of pitch and duration, the alteration of sound in character, approaching a tympanitic note, which I shall allude to but not dwell on; partly because it would lead me into discussions at variance with the limits I have set myself in this paper; partly because I have not fully solved some of the problems presented, and wish here rather to announce such general facts and laws as experience has abundantly proved.

When we have the deposit decided, and dulness manifest on ordinary percussion, respiratory percussion may show but little change in forced inspiration, except a slight rise in pitch, or the pulmonary resonance may be partly restored. In the former case the deposition is extensive; in the latter it is not; and we may thus have some means of gauging the amount of disease in the portion of lung over which we are examining, or, in other words, of seeing about how much of the pulmonary tissue is still capable of performing its function. Where we have both the apices decidedly affected, the physical signs by the method of exploration under discussion are not so easily made out, as comparison becomes more difficult; yet we generally find that the resonance of neither side is increased, is in truth usually decreased on full held inspiration, while the pitch is raised, and that forced expiration shows dulness and considerable resistance to the striking finger. As regards the forms of consumption, there has not, so far as I have studied the matter, been any difference discernible; indeed, as the same physical conditions may occur, so will the same physical signs. In instances of pneumonic phthisis I have often found, where the disease affected the lower lobe, the most obvious dissimilarity between the lower and upper parts of the chest; if percussed during the acts of breathing, large portions of the lung may still partially clear up. But there is nothing different in this respect from what has already been said in speaking of chronic pneumonic consolidation.

When, in a case of phthisis, we find that the dulness on percussion is no longer modified by the forced inspiration, we have a certain test of the malady having progressed. And this test may be made a very delicate one. I have recently examined a gentleman in whom the physical signs of crackling and prolonged expiration were the same as when noted eight months ago. The vesicular murmur had become feeble in inspiration; this was the only decided change. Yet he had night-sweats, was worse in several respects, and respiratory percussion alone, which showed dulness scarcely influenced, and very unlike what it was at first, really demonstrated that the lung affection had extended, and brought the physical signs into connection with the general symptoms.

Let us now turn to the stage of phthisis in which cavities have formed. Do we derive any information here from respiratory percussion? Yes, most interesting. We find the percussion note in full inspiration altering

to dulness, and this whether we have that mixture of dull and tympanitic sound encountered in percussing over cavities, or the cracked-pot sound, or the amphoric note. Some remnant of the peculiarity of the original sound may remain; but the character of the bulk of the sound is altered. It has become dull, and there is more resistance, and usually a higher pitch. Let me cite briefly a few illustrative cases, selected from many and very similar observations.

The case of a man in the Pennsylvania Hospital in January of this year, who had, immediately under the left clavicle, crackling, prolonged expiration, some dulness; in the second interspace, two inches from the left of the sternum, cracked-pot sound, bronchophony, approaching to pectoriloquy, respiratory sounds obscured by heart-sounds. Full held inspiration lessened the dulness somewhat immediately under the clavicle, and raised the pitch; its effect on the spot of the cracked-pot sound was to largely destroy it, render the sound duller, heighten the pitch.

In the case of a tubercular woman in the hospital in 1871, occupying Bed 13, there was hollow respiration under the right clavicle. Percussion showed dulness, mixed with a tympanitic sound; the note became duller, and of higher pitch on full held inspiration. On the left side anteriorly, where amphoric respiration and amphoric percussion sound were found, forced inspiration produced the most marked change to decided dulness.

A man died in the hospital in December, 1870, who, examined a few days prior to death, presented at the left apex dulness mixed with a cracked-pot sound; at the lower part of the chest the sound was simply dull. There was dulness on percussion also at the right apex. A full held inspiration seemed to develop this more decidedly, and raised the pitch. At the left apex the sound became duller, and the cracked-pot sound disappeared. The dulness at the lower part of the chest was somewhat lessened. At the autopsy there was almost uniform infiltration of tubercle of the upper lobe of the right lung anteriorly, less posteriorly; in the upper lobe of the left a cavity was detected $3\frac{1}{2}$ by 2 inches, the long axis extending obliquely downwards and somewhat backwards. The walls anteriorly and at the apex were only one-sixth of an inch in thickness. The remainder of the lung was much infiltrated, with grayish and cheesy masses.

Bed 6 was occupied in the winter of 1871 by a man who presented whispering pectoriloquy, percussion dulness mixed with cracked-pot sound, which yielded to simple dulness on forced inspiration. At the autopsy a considerable cavity was found at the upper part of the left lung.

In Bed 5 of the men's medical ward of the Pennsylvania Hospital a case terminated fatally, which, examined the day before death, had shown, besides the auscultatory phenomena of a cavity at the upper part of the right lung, a tympanitic percussion note mixed with dulness, which, on full held inspiration, became very much duller. A large cavity was found

occupying the right apex, and extending downwards posteriorly about three inches.

The law these cases illustrate I hold to be invariable where the cavity is of any size. I suppose the explanation lies in the tenser condition of the walls of the excavation produced by the forced breathing. This may be the reason why the more rigid walls of a bronchial dilatation are not thus modified, and do not show the altered percussion phenomena; and I believe that we shall find in this a means which, in doubtful instances, will decide between the two affections. I cannot quite positively say that no change ever takes place in bronchial dilatation, for the opportunities of investigating marked cases of this comparatively rare disorder have not been very many since I have been studying the subject. But I can say, that thus far I have found the rule laid down without exception. Not only is there no dulness produced on full held inspiration over the seat where the auscultatory signs of a cavity are caused by the dilated bronchus, but, as I had occasion to study in a case that presented itself last October, and was watched for some time, the mixed, dullish yet vesiculo-tympanitic percussion resonance became much clearer, and rather more tympanitic, nearly all dull admixture being lost.

We have thus far, for the most part, been examining affections in which alterations of dulness and questions of consolidation are the most prominent. We may now review some in which excessive clearness, or at least modifications produced by large amounts of air, are the striking traits; for example, pneumothorax and emphysema. In *pneumothorax* I think that respiratory percussion will tell us—a point often of a great deal of doubt, yet of much importance—whether the opening through which the lung communicates with the pleural sac is closed or not. When full inspiration does not modify the percussion note, the former state of things exists, excepting if the lung be expanding again after tapping, or the use of the aspirator. When the extreme resonance, or the tympanitic or amphoric note is essentially changed, we may, I believe, infer that the air still rushes from the lung into the artificial cavity in the pleura. I say I believe; because, though it has proved so in every instance I have thus far examined, I have not in enough compared the post-mortem results to announce the law as an invariable one. From this case under my care at the Pennsylvania Hospital in 1870, some of the points alluded to can be well learned.

A young Canadian, evidently tubercular, had, five weeks before admission, sharp pain in the right side of the chest, followed by great shortness of breath. Percussion yielded an amphoric note from the third rib down; above it was dull, with an amphoric admixture of sound. Auscultation showed metallic breathing, but neither tinkling nor splashing was discernible. Full held inspiration at the right apex rendered the percussion sound clearer and more resonant; below the third rib it dulled

it, almost destroyed its amphoric character, heightened the pitch. This observation was repeated over and over again. On opening the thorax at the autopsy, a large amount of air escaped from the right pleural cavity, which contained no fluid whatever. The lung was very much compressed and contracted, and adherent to the chest-walls by long, but thick adhesions. It showed tubercular deposits, and a few points of softening near the pleura; one of these had bursted, and the point of rupture was found in the anterior surface of the lung, just below the apex.

In *pulmonary emphysema* respiratory percussion gives most valuable information. It helps us to establish the presence of the disease; it enables us to form some idea as to its extent. And it does so in this manner: In marked emphysema the excessively clear or vesiculo-tympanitic note is unchanged by percussing during the act of breathing; when the emphysema is not so great, it is slightly changed. But if emphysema be present at all, except to a trifling degree, the sound is not very much altered, and we are thus, in many a doubtful case, with asthmatic symptoms, greatly aided in deciding whether dilatation of the air-vesicles exist or not. I have notes of numerous observations proving the correctness of these statements, and I had thought of illustrating this part of the subject with them. But they are so positive, and the general law they make out is so clear, that it would seem a useless reiteration of readily ascertained facts. In truth, I look upon the evidence elicited by respiratory percussion with reference to emphysema as being one of the most serviceable contributions that has come from its study.

Thus here, as in previous sections of this paper, I have endeavoured to show how respiratory percussion may be made available alike in detecting disease and in ascertaining its limits. I have tried to make clear that it helps us often where we most need help; and though it requires care and some training to practise, it does not do so in any greater degree than that important science of which, I trust, it may form henceforth a recognized branch.



